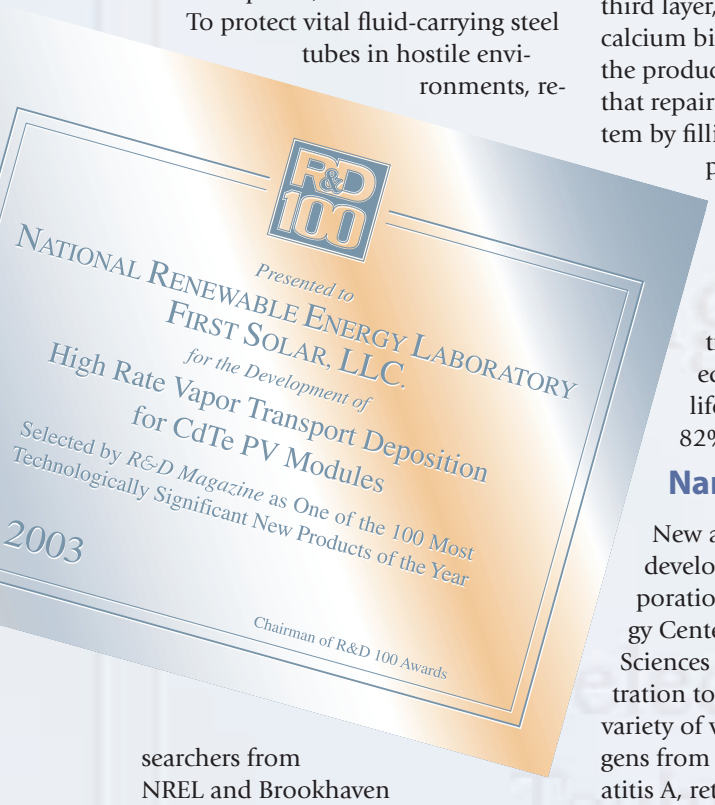
Awards & Honors

Since the last publication of the *Research Review*, NREL, its researchers, and partners have received several awards and honors. Among these are four R&D 100 awards, two tech transfer awards from the Federal Laboratory Consortium (FLC), recognition by *Scientific American*, and a newly elected fellow of the American Association for the Advancement of Science (AAAS).

PPS Protection

Carbon steel is tough, but not tough enough to withstand harsh conditions found in geothermal power plants, chemical plants, and railroad tank cars.

To protect vital fluid-carrying steel tubes in hostile environments, researchers from NREL and Brookhaven National Laboratory (BNL) developed a polymer-based coating system called polyphenylenesulfide (PPS). This technology, which won both an R&D 100 award and an FLC technology transfer award, was transferred to Bob Curran & Sons for further refinement and commercialization. Within nine months of first being contacted about the technology by NREL and BNL, the company had incorporated PPS into a commercial product. It now represents the primary line of business for Bob Curran & Sons, which has built a new facility near Houston to better serve its burgeoning roll of customers in the petrochemical processing industry.



A PPS coating is not only tough, it is smart. Its three-layer construction divides the duties, with the innermost one — a zinc phosphate ceramic primer — assigned to create a strong bond with the steel. The second layer, typically a carbon fiber PPS matrix, provides toughness, corrosion protection, and high thermal conductivity. The third layer, a polymer blend of PPS, calcium bialuminate, and Teflon, gives the product a self-healing mechanism that repairs damage to the coating system by filling in small cracks due to physical wear.

PPS extends the life of untreated carbon steel by fivefold. Even when compared to stainless steel or titanium tubes, PPS-coated carbon steel tubes yield a life-cycle cost savings of up to 82%.

Nanofiber Protection

New alumina ceramic nanofibers developed by NREL, Argonide Corporation, and the Design Technology Center of the Russian Academy of Sciences can be used in bioactive filtration to eliminate 99.99999% of a variety of viruses, bacteria, and pathogens from fluids. This includes hepatitis A, retroviruses, adenoviruses, coxsackle, Salmonella, shigella dysenteriae, and E. Coli. The fibers also can be used in bone tissue engineering, to eliminate 99.99% of heavy metals in water, and to reduce arsenic in drinking water to well below federal and international standards.

The fibers' remarkable capabilities derive from their unique combination of small diameter (about 2 nm), long length (up to hundreds of nm), a surface area of 600 m^2/gm, and surface chemistry that can be tailored. Trademarked and marketed as NanoCeram by the Argonide Corporation, the nanofibers arrive with good timing, in light of heightened concerns about bio-terrorism and national security.

Letting in Light

BP Solar's PowerView module, developed jointly with NREL, doubles as architectural glass and a PV module. Particularly useful for sloped glazings such as awnings, BP has installed it at hundreds of its Connect fueling and retail sites, where much of the electricity demand is met with their own futuristic, semi-transparent canopies.

Helping make PowerView possible was an innovative manufacturing method from BP Solar, in which programmable lasers were used to selectively remove material from the thin-film PV module to allow light through while minimizing the decrease in electrical power. Although an innovative technology, this R&D 100-award winner fell victim to a BP Solar reorganization that dropped thin-film modules from the company's PV product line.

A Module a Minute

First Solar's automated, non-stop, continuous-feed production line can crank out one PV module per minute — and these are 60 cm x 120 cm, high-quality modules made of thin-film cadmium telluride (CdTe) and cadmium sulfide (CdS). How is it done? Soda-lime glass is fed into vacuum deposition chambers where a layer of CdTe is deposited on the glass, followed by a layer of CdS. The modules are then laser-scribed, metallized, and encapsulated in ethyl-vinyl acetate, and then another layer of soda-lime glass.

The enabling core of this process is the R&D-100-award-winning high-rate vapor transport deposition technology developed by First Solar and NREL. This is a deceptively simple technology that can deposit a thin, uniform

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Dr. Bhushan Sopori demonstrates PVSCAN, one of the technologies that he developed and helped transfer to industry, and for which he won an FLC award.

layer of CdTe or CdS on glass substrate in less 40 seconds — a deposition rate three to four orders of magnitude greater than rival thin-film PV technologies.

It is the world's first such mass-production method for making polycrystalline thin-film modules. In its first year of production, the technology helped First Solar cut the price of PV modules to $2.50 per watt. A second-generation production line now under construction could lower the price by nearly another 50% in the next three years.

Monitoring Manufacturing

By transferring two related technologies to GT Equipment Technologies, Inc. (GTi), a manufacturer of equipment for semiconductor and PV materials processing, NREL helped fill a need in the international solar energy community.

One of the two technologies, PVSCAN, is a high-speed, optical-scanning system that maps and analyzes defects in PV wafers and cells. The other, the PV Reflectometer (marketed as the GT-Fabscan 6000), is used to monitor important parameters in solar-cell processes including surface roughness and texture, metallization, antireflection coatings, and back contact properties.

The theory behind both technologies, as well as their design and engineering, are products entirely of NREL researchers, who also helped negotiate licensing of the technologies by GTi and worked closely with the company to scale them up to production. These efforts will yield additional benefits to NREL in the form of new relationships with R&D groups, universities, and PV makers and other companies from the United States and abroad.

Scientific American 50

In its debut issue of spotlighting the top 50 business and research leaders of the year, *Scientific American* magazine recognized NREL and Spectrolab, Inc. as leaders in the energy category for their work in increasing the efficiency of PV cells.

NREL's research in multijunction solar cells for more than a decade has led the way to ever-more-efficient cells, offering the potential of cheaper electricity from the sun. Multijunction solar cells use multiple layers of semiconducting material to absorb sunlight and convert it to electricity more efficiently than single-junction cells.

In 2001 — using a solar-cell design licensed from NREL — Spectrolab made a gallium indium phosphide/gallium arsenide/germanium ($GaInP_2$/GaAs/Ge) triple-junction solar cell that converted 34% of sunlight to electricity under concentration — a world record at the time. Since then, the company has improved the conversion efficiency to 36.9% under 309 suns concentration.

This technology has won two R&D 100 awards. The first was won by NREL in 1991 for a double-junction cell ($GaInP_2$/GaAs) whose primary use is for space applications. The second award was presented to both NREL and Spectrolab in 2001 for the triple-junction device.

Art Nozik Elected AAAS Fellow

Arthur J. Nozik was recently elected a fellow of the American Association for the Advancement of Science, the highest distinction bestowed on AAAS members by their peers

Dr. Nozik is a senior research fellow at NREL. During his tenure at the Laboratory, he has established himself as a leader in photoelectrochemistry, semiconductor-molecular interfaces, quantization effects, carrier dynamics, and the application of these interdisciplinary sciences to the conversion of photon energy to electricity or fuels (such as hydrogen or alcohols).

Dr. Nozik received his Ph.D. in physical chemistry from Yale University in 1967 and joined NREL in 1978, where he has been a research fellow since 1983 and has been recognized with several important Laboratory-wide distinctions, including the Van Morriss award, the Hubbard Award, and an award for outstanding achievement. He has published more than 160 peer-reviewed publications, edited several books in his fields of expertise, been awarded 11 U.S. patents, and served as a senior editor on *The Journal of Physical Chemistry* since 1993.

Dr. Arthur Nozik becomes a fellow of the AAAS.